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Abstract

SEED AND BLANKET REACTORS (EXPERIENCE, DISTINGUISHING FEATURES, PHYSICS, LONG RANGE POTENTIAL)

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The basic features and advantages of seed blanket reactors will be presented. The concentration of highly enriched fuel in nearly critical seed regions results in reduction of enriched fuel requirements, centralization of control, and the feasibility of tailoring the nuclear environments to the optimum both for the highly enriched and for the fertile fuels.

The Shippingport Reactor Core 1 recently completed operating with its fourth and last seed. Except for minor replacements and relocations performed during refueling of the seed, the natural uranium in the blanket region of the core has remained in place throughout the entire lifetime of the core. At the time of each seed refueling, several blanket fuel elements have been removed from the core for study. Isotopic analysis of the fuel material in these rods provides a basis for evaluation of the techniques employed in calculation of the behavior of natural uranium during extended irradiation in a seed-blanket arrangement.

The most straightforward and most meaningful method of employing the experimental data to evaluate a design depletion calculation is to compare the experimental results for each individual rod directly with the isotopic concentrations given for each rod by the calculation.

The results indicate general adequacy of the calculational model for the U-235 depletion and build-up of plutonium isotopes. Although there are isolated discrepancies of as much as 20%, the average difference between calculation and experiment is well within 10%.

The advantages of the seed-blanket core concept are enhanced in large reactors. For example, the core can be controlled by varying the seed geometry, without the use of parasitic poisons. Still further gains can be obtained by application of the seed-blanket concept to the thorium cycle. Several thorium cycle designs are discussed: a thorium converter burner core designed for ten years' operation without refueling; a converter recycle design optimized for breeding; a thorium burner core with the central region optimized for breeding.

The effects of long recycle of the U-233 fuel to equilibrium composition is discussed, including evidence that the seed-blanket breeder core design can continue to breed even after over 100 years of fuel recycling.

The experimental work and theoretical methods which have been developed for seed-blanket cores are described and discussed.

The paper concludes with a brief comparison of the potential of the seed-blanket core with other types which have been proposed for large nuclear power plant operation.